Practices on Shiftings, Compressions and Expansions, and Reflections.

1. Let $f(x) = x^2$.
   a. Find the function $g$ (write down the function) so that $y = g(x)$ is a reflection of $y = f(x)$ with respect to the $x$-axis. [answer: $g(x) = -x^2$]
   b. Find the function $h$ (write down the function) so that $y = h(x)$ is a shifting of $y = f(x)$ left 30 units and down 30 units. $h(x) = (x + 30)^2 - 30$.
   c. Find the function $k$ (write down the function) so that $y = k(x)$ is a shifting of $y = g(x)$ left 30 units and down 30 units. $k(x) = -(x + 30)^2 - 30$.
   d. If $l(x) = -\frac{1}{2}x^2$, sketch $y = f(x)$ and $y = l(x)$ together.

2. If $f(x) = -(x - 1)(x - 3)$
   a. Describe the relationship between $y = f(x)$ and $y = -f(x)$. Sketch the graph of $y = -f(x)$.
   b. Describe the relationship between $y = f(x)$ and $y = f(-x)$. Sketch the graph of $y = f(-x)$
c. Describe the relationship between $y = f(x)$ and $y = f(x + 3)$. Sketch the graph of $y = f(x + 3) [y = f(x + 3)$ is being shifted to the left 3 units from $y = f(x)].$

![Graph of f(x) and f(x+3)](image)

d. Describe the relationship between $y = f(x)$ and $y = f(x) + 3$. Sketch the graph of $y = f(x) + 3 [ y = f(x) + 3$ is being shifted up 3 units from $y = f(x)].$

3. If $f(x) = -\sqrt{x-1}$

a. Describe the relationship between $y = f(x)$ and $y = -f(x)$. Sketch the graph of $y = -f(x) [ y = f(x)$ is in black and $y = -f(x)$ is in green].

![Graph of f(x) and -f(x)](image)

b. Describe the relationship between $y = f(x)$ and $y = f(-x)$. Sketch the graph of $y = f(-x) [ y = f(-x)$ is being reflected along $y-axis$ from

![Graph of f(x) and f(-x)](image)
\[ y = f(x). \]

c. Describe the relationship between \( y = f(x) \) and \( y = f(x - 3) \). Sketch the graph of \( y = f(x - 3) \). [\( y = f(x - 3) \) is being shifted to the right 3 units from \( y = f(x) \).]

d. Describe the relationship between \( y = f(x) \) and \( y = f(x) - 3 \). Sketch the graph of \( y = f(x) - 3 \). [\( y = f(x) - 3 \) is being shifted down 3 units from \( y = f(x) \).]

e. Describe the relationship between \( y = f(x) \) and \( y = 2f(x) \). Sketch the graph of \( y = 2f(x) \). [\( y = f(x) \) is in green and \( y = 2f(x) \) is in red].